PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :
B01D 69/10, 65/00, 63/08, 71/26

A1

(11) International Publication Number: WO 98/01219

(43) International Publication Date: 15 January 1998 (15.01.98)

(21) International Application Number: PCT/JP97/02340

(22) International Filing Date: 7 July 1997 (07.07.97)

(30) Priority Data:

8/179081	9 July 1996 (09.07.96)	JP
8/228365	29 August 1996 (29.08.96)	JP

(81) Designated States: CN, KR, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

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(54) Title: A FILTER MEMBER

(57) Abstract

The present invention provides a filter member having excellent handling properties when preparing the element and module for membrane separation from the filter member featuring a high porosity and excellent filtering capacity, and excellent durability as filters for waste water treatment. A filter member comprises a porous filter membrane of a synthetic resin and a water-permeable reinforcing sheet laminated on the membrane wherein the membrane and sheet are joined by spot-bondings scattered over an interfacial phase of lamination with the area of spot-bondings at any portion thereof being in the range of 0.05-0.35 cm^2 per 1 cm^2 of said interfacial phase.

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DESCRIPTION

A Filter Member

Field of the Invention

The present invention relates to a filter member, more particularly to a filter member suited for membrane separation, for example, to treat waste water or to ensure drinking water in the event of a disaster or for use in the field.

Background of the Invention

A variety of porous filter membranes have been used as filters for waste water treatment. These porous filter membranes are laid out on a frame body for use. Above all, a porous synthetic resin membrane comprising a high molecular weight polyethylene is used over an extensive range because of high porosity, excellent filtering capacity and economic advantages. (For example, see Japanese Patent TOKKAI-HEI No. 2-232242 (1990), TOKKAI-HEI No. 5-98065 (1993), TOKKAI-HEI No. 5-239246 (1993) and TOKKAI-HEI No. 5-245923 (1993)).

Such a porous synthetic resin membrane comprising the polyethylene featuring high porosity and excellent filtering capacity provides an excellent tensile strength for the thin membrane in the machine direction and traverse direction, despite its high porosity since it comprises a high molecular weight polyethylene and is formed by high degree of stretching; whereas it is less strong in tear strength despite its flexibility, since the fibrous non-woven structure is formed in the direction of thickness. Accordingly, extreme care is required in handling the thin membrane when making an element for membrane separation by using this porous synthetic resin membrane of polyethylene laid out on the frame body, and making a module using this element. For example, there are problems such as easy separation from the surface layer when caught by small protrusions. Furthermore, when the module with the built-in element is used for waste water treatment, foreign substances in waste water will be caught by the surface layer and when discharged by a large amount of fluid, fine portions of the thin membrane in the element will be damaged, and the

thin membrane itself will be damaged over time -- this fails to meet practical requirements. Problems of a similar nature will occur.

When abnormal pressure has occurred in filtration of a large amount of fluid with the module using this porous synthetic resin membrane of polyethylene featuring a high porosity and excellent filtering capacity, or when pressure is applied to remove the filtered matter deposited on the element after filtration of a specified amount (the so-called "backwashing"), it is necessary that applied pressure be distributed over the entire membrane surface. To meet this need, the thin membrane itself must have a certain rigidity, thereby improving durability in repeated use.

Generally, when a filter membrane is used, its combination with a supporting body is more prevalent. Needless to say, the supporting body for a filter membrane must allow the permeation of liquid more easily than the filter membrane itself. At present, a polyester non-woven fabric is used for this supporting body, and many improvements have been made. For example, Official Gazette of Japanese Patent No. TOKKO-HEI NO.4-21526 (1992) discloses as the supporting body a multi-layered non-woven fabric based on the dual structure comprising a front surface layer having a greater aperture and surface roughness using thick fibers, and a back surface layer having a smaller aperture and compact structure using fine fibers. However, this multi-layered non-woven fabric consisting of staple fibers serves to decrease variations in the thickness and water permeability of the non-woven fabric as the supporting body of the filter membrane; it is not intended to solve these problems which arise when said porous synthetic resin membrane of polyethylene featuring a high porosity and excellent filtering capacity is used as a filter membrane. At present, such problems as above-mentioned remain to be solved.

Summary of the Invention

The present invention is intended to solve the problems involved in a conventional porous filter membrane using a

porous synthetic resin membrane of polyethylene characterized by a high porosity and excellent filtering capacity, to ensure improvements in handling when preparing the element and module for membrane separation from the porous synthetic resin membrane, and to provide a porous filter member of excellent durability which ensures stable filtration of a large amount of fluid as in waste water treatment for a long time, without the filter member being damaged.

In an effort to solve these problems, the inventors of the present invention have found that these problems can be solved by lamination through spot-bondings of a water-permeable reinforcing sheet to a porous synthetic resin membrane under specific conditions. This finding has led to the present invention.

The present invention thus provides the following embodiments of a filter member:

(1) A filter member comprising a porous filter membrane of a synthetic resin and a water-permeable reinforcing sheet laminated on the membrane wherein the membrane.and sheet are joined by spot-bondings scattered over an interfacial phase of lamination wherein the area of spot-bondings at any portion thereof is in the range of 0.05 - 0.35 cm^2 per 1 cm^2 of the interfacial phase.

(2) A filter member according to (1) wherein the spot-bondings are dot-like bondings.

(3) A filter member according to (1) wherein the spot-bondings are linear bondings.

(4) A filter member according to (1) wherein the spot-bondings are polygonal bondings.

(5) A filter member according to (1) wherein the spot-bondings are bondings with a network structure.

(6) A filter member according to any one of (1) to (5) wherein the water-permeability of the membrane is 1 to 10 cc/min./cm^2.

(7) A filter member according to (6) wherein the membrane comprises a high molecular weight polyethylene having a molecular weight of 5×10^5 to 7×10^6, and contains a large

number of very fine pores providing a porosity of 60 to 90% and a pore diameter of 0.1 to 2.0 microns, the tensile strength and the tear strength in at least one of the machine and traverse directions of the membrane being 3.5 kg/5 cm or more, and 5 to 50 gram, respectively.

(8) A filter member according to any one of (1) to (5) wherein the tear strength of the sheet in at least one of the machine and traverse directions is 0.2 kg or more.

(9) A filter member according to (8) wherein the sheet is a fibrous cloth.

(10) A filter member according to (9) wherein the cloth is a woven fabric.

(11) A filter member according to (9) wherein the cloth is a non-woven fabric consisting of continuous fibers.

(12) A filter member according to (8) wherein the sheet is a porous film.

Brief Description of the Drawings

Fig. 1 is a perspective view of a schematic drawing representing an embodiment of a filter member laminated with a woven fabric as a water permeable reinforcing sheet according to the present invention.

Fig. 2 is a perspective view of a schematic drawing representing an embodiment of a filter member laminated with a porous film as a water-permeable reinforcing sheet according to the present invention.

Fig. 3 is a schematic drawing representing various forms of spot-bondings scattered over an interfacial phase of lamination of the present invention.

Fig. 4 is a perspective view representing an embodiment of an element for filtering treatment using a filter member according to the present invention.

Fig. 5 is a cross sectional view at A-A in Fig. 4 in the direction of the arrow.

Fig. 6 is a perspective view representing an embodiment of a reinforcing bar used for an element for filtering treatment based on a filter member according to the present invention.

Fig. 7 is a perspective view representing an embodiment

of a filler used for an element for filtering treatment based on a filter member according to the present invention.

Fig. 8 is a perspective view representing an embodiment of an element for filtering treatment based on a filter member according to the present invention.

Fig. 9 is a cross sectional view of A-A in Fig. 8 in the direction of the arrow.

In these figures, the reference numbers have the following meaning:

1. Filter member
2. Porous filter membrane of synthetic resin
3. Water-permeable reinforcing sheet (woven fabric)
4. Water permeable reinforcing sheet (porous film)

(a) Dot-like spot-bondings
(b) Linear spot-bondings
(c) Polygonal spot bondings
(d) Network spot bondings

11. Frame body
12. Network body
13. Felt
14. Outlet
15. Penetration hole
16. Reinforcing bar
17. Space for reinforcing bar
18. Outlet connected to the outlet of the element for filtering treatment
19. Filler member
21. Bag body
22. Form-retaining member
23. Outlet
24. Sealed portion
25. Water passageway

Detailed Description of the Invention

A porous synthetic resin membrane can be exemplified by various porous membranes comprising polytetrafluoroethylene, polysulfone or high molecular weight polyethylene, where the water permeability is preferred to be

1 to 10 cc per min. per square centimeter. Here water permeability characteristic is one obtained by converting the amount of pure water permeating the synthetic resin membrane (area: 4.7 cm x 4.7 cm) for one minute under a pressure of 0.5 kg/cm^2 into the units of "$cc/min./cm^2$". To get such water permeability, the porous synthetic resin membrane is preferred to have a large number of very fine pores providing a porosity of 60 to 90% and a pore diameter of 0.1 to 2.0 microns.

Here porosity is calculated according to the following equation from the density (ρo) of the starting material and density (ρ) of synthetic resin membrane after molding:

$$\text{Porosity } (\%) = (1 - \rho/\rho o) \times 100$$

If the pore diameter is too small, clogging tends to occur and sufficient durability cannot be ensured, whereas filtering capacity is poor if it is too large. Proper selection of pore diameter and its number allows the porosity of the porous synthetic resin membrane, and water permeability wherever practicable, to be established. This makes it possible to show the maximum filtering capacity of the porous filter member according to the present invention.

Especially, the porous membrane comprising an ultra-high molecular weight polyethylene having a molecular weight of 5×10^5 to 7×10^6 is preferably used. If the molecular weight is too high, molding into a porous membrane will be difficult; whereas if it is too low, the strength of the porous membrane will be reduced, making it difficult to provide a high porous membrane with excellent filtering capacity.

Furthermore, the polyethylene may be copolymerized with a small amount (preferably 5 mol % or less) of propylene, butene, pentene, hexane, 4-methylpentene-1, and octene. Also, it may contain a small amount (for example, 25 wt % or less) of polypropylene, polybutylene, and ethylene-propylene copolymer. In addition, the polyethylene may contain the normally used additives such as a stabilizing agent, a coloring agent, a flame retarding agent and a static eliminating agent.

Such porous polyethylene membranes having a large number of very fine pores can be manufactured according to the

procedures disclosed in the Official Gazette of Japanese Patent Laid-Open Nos. TOKKAI-HEI 2-232242 (1990), TOKKAI-HEI 5-98065 (1993) and TOKKAI-HEI 5-239246 (1993). For example, the solution (concentration: 2 to 30 wt %) obtained by dissolving an ultra-high molecular weight polyethylene having a molecular weight of 5×10^5 into a solvent such as decalin is extruded from a slit-formed die to form a gel film; then it is stretched at a high stretching rate after the solvent has been evaporated in the gel film.

Such polyethylene porous synthetic resin membrane preferably has a weight of 5 to 15 grams/m^2 and a thickness of 25 to 60 microns. Since it is composed of an ultra-high molecular weight polyethylene and formed by stretching at a high degree of stretching in the machine and traverse directions, it is preferred to have a high porosity and a tensile strength of the porous membrane in at least one of the machine and traverse directions being 3.5 kg/5 cm or more.

Furthermore, the polyethylene porous synthetic resin membrane which can be used in the present invention exhibits a fibrous non-woven structure in the direction of thickness, but the tear strength in at least one of the machine and traverse directions is preferred to be 5 to 50 grams. To meet this need, it is preferable to improve the interlaminar strength of the fibrous non-woven structure by calendering, thereby ensuring upgraded durability.

A filter member according to the present invention comprises the porous membrane and a water-permeable reinforcing sheet laminated on the membrane in order to improve tear strength, rigidity and durability. The water-permeable reinforcing sheet of various materials and forms can be used if the high porosity and high filtering capacity of porous filter membrane are not degraded, namely, if it has the same or greater water permeability than the porous synthetic resin membrane (1 to 10 cc/min/cm^2).

However, a reinforcing sheet having a tear strength of 0.2 kg or more in at least one of the machine and traverse directions is preferred. The fibrous cloth or porous film is

preferably used as such a water-permeable reinforcing sheet.

The woven, knitted or non-woven fabric can be used as the fibrous cloth, and especially a woven fabric or non-woven fabric consisting of continuous fibers is preferred. As a material, polyester, polyamide, polyolefin or polyvinyl chloride can be selected as required, and the use of polyester or polyolefin is preferred. When a cloth is used, a weight of about 10 to 150 grams/m^2 is preferred.

When a fibrous cloth is used as the reinforcing sheet, the cloth may be quilted, thread strips of high strength may be inserted at a specified interval in the longitudinal and/or traverse direction of the cloth, or tape-formed synthetic resin membrane may be partially bonded to the cloth.

When a porous film is used, a pore diameter of 0.1 to 2.0 mm, a porosity of 30 to 90 %, and a film thickness of 5 to 500 microns are preferred. Especially the use of polyester or polyolefin as the porous film is preferred.

A filter member according to the present invention comprises a porous filter membrane of a synthetic resin and a water-permeable reinforcing sheet laminated on the membrane, each having the above characteristics. What is very important is that the membrane and sheet are joined by spot-bondings scattered over an interfacial phase of lamination wherein the area of spot-bondings is in the range of 0.05 - 0.35 cm^2 per 1 cm^2 of the interfacial phase when taken at any portion thereof.

It goes without saying that the interfacial phase of lamination can be present on one side or both sides (that is, water-permeable reinforcing sheet on both sides of the porous synthetic resin membrane).

Fig. 1 is a perspective view of a schematic drawing showing an embodiment of a filter member 1 laminated with woven fabric 3 as a water-permeable reinforcing sheet on a porous synthetic resin membrane 2. Here, T is a partial schematic showing the relation between warp and weft yarn consisting of woven fabric 3. D, D' is a partial schematic showing the spot-bondings per 1 cm^2 scattered over an interfacial phase

of lamination.

Moreover, D shows the spot-bondings in a partial schematic S, wherein the fabric 3 is peeled from the membrane 2 at an interfacial phase of lamination and D' shows the image of the spot bondings at inner interfacial phase of lamination. Furthermore, each area of D and D' is 1 cm^2, and at D the membrane 2 and sheet 3 are joined by dot-like spot-bondings (d_1, d_2, d_3, d_4) and the total area of the spot-bondings is in the range of 0.05 - 0.35 cm^2.

Fig. 2 is another perspective view of the schematic drawing showing an embodiment of a filter member 1, laminated with porous film 4 as a water-permeable reinforcing sheet on a porous synthetic resin membrane 2. Here, P is a partial schematic showing small pores formed in the porous film 4. L, L' is a partial schematic showing the spot bondings per 1 cm^2 scattered over an interfacial phase of lamination. Moreover, L shows the spot-bondings in a partial schematic S, wherein the film 4 is peeled from the membrane 2 at an interfacial phase of lamination and L' shows the image of the spot bondings at inner interfacial phase of lamination. Furthermore, each area of L and L' is 1 cm^2, and at L the membrane 2 and film 4 are joined by linear spot-bondings ($\ell 1$) and the area of said spot-bondings is in the range of 0.05 - 0.35 cm^2.

In a filter member according to the present invention, the tear strength, rigidity and durability of the porous synthetic resin membrane must be improved by ensuring that the fine pores of the porous synthetic resin membrane will not be blocked by spot-bondings scattered over an interfacial phase of lamination with a water-permeable reinforcing sheet. This requires that the area of spot-bondings is in the range of 0.05 - 0.35 cm^2 per 1 cm^2 of the interfacial phase when taken at any portion thereof. If the area of spot-bondings is below 0.05 cm^2, the above target cannot be achieved. If the area of spot-bondings exceeds 0.35 cm^2, water-permeability will be reduced, namely, filtering capacity will be reduced --- this fails to meet practical requirements.

As described above, to ensure the specified area of spot-bondings with the minimum blocking of the fine pores of the porous synthetic resin membrane, spot-bondings preferably have a dot-like, linear, polygonal or network structure.

Fig. 3 is a schematic diagram showing the various forms of spot-bondings. Symbol (a) denotes dot-like spot-bondings with a very small area, and dot-like spot-bondings are scattered such that a specified bonded area will be formed per 1 cm^2 of the interfacial phase when taken at any portion thereof. Symbol (b) represents linear spot-bondings formed by a straight line ((b)-1) or curve ((b)-2) having the width and length. Symbol (c) denotes polygonal spot-bondings ((c)-1) formed by straight line or curve having the width and length connected with each other with a space left inside, or polygonal spot-bondings ((c)-2) as its condensed form. Symbol (d) denotes spot-bondings with a network structure formed by the straight line or curve having the width and length. Similar to spot-bondings of (a), spot-bondings of (b), (c) or (d) are scattered to form a specified area per 1 cm^2 of the interfacial phase when taken at any portion thereof.

Of these various forms of spot-bondings, the spot-bondings having numerous straight or curved spot-bondings will provide greater reinforcement effect on the same area of spot-bondings.

Accordingly, polygonal spot-bondings are especially preferred to dot-like spot-bondings because they ensure that greater reinforcement effect, and filtering capacity are compatible with each other with the reduced area of spot-bondings.

As discussed above, the spot-bondings of a dot-like, linear, polygonal or network structure can be formed on an interfacial phase of lamination by the method of bonding by heat and pressure after applying a bonding agent to the gravure roll engraved in a specified shape, or jetting a hot melt bonding agent in the form of filament or powder, and ultrasonic or other thermal sealing methods which do not use any bonding agent.

To use a filter member of the present invention for waste water treatment, the member is preferably made into the filtering element laid out on both sides of the frame body or the filtering element molded in the bag form.

Fig. 4 is a perspective view representing the embodiment of an element for filtering treatment utilizing a filter member according to the present invention.

Fig. 5 is a cross sectional view of A-A in the direction of the arrow, representing the element. Numeral 1 denotes a filter member according to the present invention, 11 a frame body, 12 a network body, 13 a felt and 14 an outlet.

Fig. 8 is a perspective view showing another form of the element or filtering treatment using a filter member according to the present invention.

Fig. 9 is a cross sectional view A-A in the direction of the arrow, representing the element. Numeral 1 denotes a filter member according to the present invention, 21 a bag body formed of the member, 22 a form-retaining member accommodated in the bag body 21, 23 an outlet provided in the bag body 21, 24 a sealed portion of a filter member 1, and 25 a water passageway formed above the form-retaining member.

When a filter member according to the present invention is used for waste water treatment, a multiple number of elements for the filtering treatment comprising a filter member 1 of the present invention laid out on both sides of the frame body as shown in Fig. 4 for example, are arranged and installed inside the module for membrane separation; the water to be treated such as waste water is supplied from the outside, and is filtered by a filter member 1; then the filtered water is sucked by a suction pump (not illustrated), and discharged from outlet 14.

In this case, it is preferred to install the reinforcing bar 16 having the penetration hole 15 inside the frame body 11, as shown in 6. This reinforcing bar 16 holds and reinforces a filter member 1. Moreover, since the reinforcing bar 16 is provided with penetration hole 15, this ensures that water filtered by a filter member 1 flows inside the frame body 11

smoothly, thereby ensuring smooth filtration. In Fig. 6, numeral 17 denotes a space for the reinforcing bar 16, and 18 an outlet connected to the outlet 14 of the element.

Furthermore, when the element must be replaced due to clogging and the like, it will become heavy if a large amount of water remains inside the element and a large amount of labor will be required to remove it from the module for membrane separation. To solve this problem, the clearance inside the frame body 11 with the filler member 19, as shown in Fig. 7 can be filled, thereby ensuring water will not remain in the frame body 11. For example, the space 17 of the reinforcing bar 16 can be filled with filler member 19, and thus installed inside the frame body 11. For such a filler member 19, a foamed plastic product having isolated cell foams is preferred. For example, foamed polystyrene is preferably used.

Furthermore, a filter member of the present invention can be used for waste water treatment or the like as the element for filtering treatment formed in a bag body, as shown in Fig. 8. Here the bag body 21 can be made from a filter member of the present invention by forming the sealed portion 24, using an ultrasonic or other thermal sealing method employed for the production of a bag body for foodstuffs. Such thermal sealing provides low-cost and sufficient sealing properties. For example, in the case of a filter member wherein a polyester woven fabric is laminated onto a polyethylene porous synthetic resin membrane and is joined by spot-bondings, sufficient sealing properties can be obtained by providing the sealed portion using ultrasonic thermal sealing method through melting of the polyethylene placing the polyester woven fabric on the inner side and polyethylene membrane on the outer side.

Furthermore, in Fig. 8, the outlet 23 molded in a valve form in advance can be mounted on the bag body 21 according to the method similar to the above thermal sealing. Outlet 23 need not always be mounted on the corner as illustrated; it may be mounted at the center or at any other desired place. The number of outlets is not restricted to one and a multiple number of outlets can be installed.

A form-retaining member 22 is stored in the bag body 21 to prevent the bag body 21 from being crushed when filtered water is sucked from the outlet 23.

Also the element must be removed from the water to be treated on a periodic basis for inspection and replacement. In this case, the water inside the element may not be discharged immediately, and this may make it difficult to remove the element because of the weight of the remaining water. In addition, the filter member may be damaged. Such problems can be solved by using a light non-absorbing molded product having the isolated cell foam, for example, the polystyrene molded product with an isolated cell foam for the form-retaining member 22.

Furthermore, when filtered water is sucked from the outlet 23, a water passageway 25 is preferably formed on the surface of the form-retaining member 22 in order to ensure smooth passing of water and filtering due to the bag body 21, without being brought into close contact with the form-retaining member 22.

As water passageway 25, a groove may be formed, as illustrated in Fig. 9 or multiple convex and concave shapes may be formed. A meshed or corrugated groove on the entire surface of form-retaining member 22 is also effective. Furthermore, the meshed fibrous member or plastic member may be installed on the surface of the form-retaining member 22 , thereby forming a water passage.

Normally, when filtered water is sucked from the outlet 23, water permeation and filtering tend to take place only from the vicinity of the outlet 23. So it is preferred to select the form and layout of this water passageway 25 so that water permeation and filtering will take place from the entire bag body 21.

When used for waste water treatment, the element shown in Fig.8 which was formed from a filter member of the present invention into the bag body, this element is put into the water such as waste water, and water is sucked from the outlet 23; then water is filtered by the member 1 forming the bag body

21 in the direction shown by the arrow mark in Fig. 9, is sucked into bag body 21, and is removed from the outlet 23 as purified water. Furthermore, when purified water such as drinking water is required in the event of a disaster or in field use, this element can be put into the water of a river, pond and other such places to suck water from the outlet 23.

Especially when a porous membrane of high molecular weight polyethylene having a pore diameter of about 0.1 to 0.3 microns is used, bacteria can be removed almost completely. This makes it possible to get a clean water which can be used as drinking water.

The present invention solves the problems involved in a conventional filter member using a porous synthetic resin membrane featuring a high porosity and excellent filtering capacity, ensures improvements in handling when preparing the element and module for membrane separation from the porous synthetic resin membrane, and provides a porous filter member of excellent durability which ensures stable filtration of a large amount of fluid as in waste water treatment over a long period of time, without the filter member being damaged.

Furthermore, the element for filtering treatment using a filter member of the present invention can be produced by laying out the member on both sides of the frame body or molding it in the form of a bag. Especially the element for filtering treatment molded in bag form is light weight, has excellent handling and has high filtering capacity without any problems in sealing. In addition, easy mounting and dismounting of the bag body arises, and it is possible to provide at low-cost an element for filtering treatment and the module for filtering treatment incorporating said element. Thus, in addition to waste water treatment, it is expected to find applications over a variety of fields including its application to ensure a drinking water in the event of disaster or in the field.

The following describes the present invention in greater detail with reference to specific. Water permeability, porosity, tensile strength and tear strength in the examples were measured as follows:

(1) Water permeability

Water permeability was obtained by converting the amount of pure water permeating the synthetic resin membrane (area: 4.7 cm x 4.7 cm) for one minute under a pressure of 0.5 kg/cm^2 into units of $cc/min./cm^2$.

(2) Porosity

Porosity was calculated according to the following equation from the density (ρo) of the starting material and density (ρ) of synthetic resin membrane after molding:

$$\text{Porosity } (\%) = (1 - \rho/\rho o) \times 100$$

(3) Tensile strength

Tensile strength was measured in conformity to ASTM D-882.

(4) Tear strength

Tear strength is measured in conformity to JIS L-1096.

Examples 1 to 4 and Comparative examples 1 and 2

The following were utilized as s porous filter membrane of synthetic resin(A) and a water-permeable reinforcing sheet (B):

(A) Porous filter membrane of synthetic resin

- Polymer: polyethylene (Hizex Million registered trade name of Mitsui Petrochemical Industries Ltd.)
- Molecular weight (weight average): 3.3×10^6
- Water permeability: 5 $cc/min./cm^2$
- Porosity: 85%
- Pore diameter (average): 1.0 μm
- Tensile strength (machine direction): 3.8 kg/5 cm
  (traverse direction): 4.0 kg/5 cm
- Tear strength (machine direction): 12 gram
  (traverse direction): 11 gram
- Weight: $10g/m^2$
- Thickness: 50 μm

(B) Water-permeable reinforcing sheet

- Material: Polyethylene terephthalate taffeta woven fabric (Tetron registered trade name of Teijin Ltd.)
- Water permeability: 50 cc/min./cm^2
- Tear strength (machine direction): 4.0 kg
  (traverse direction): 5.0 kg
- Weight: 105 g/m^2

A urethane based adhesive (Polyflex BD registered trade name of Daiichikogyoseiyaku Ltd.) was applied in a dot-like structure using a gravure roll engraved in a dot-like structure on one side of the polyethylene terephthalate taffeta woven fabric (B) having the above-mentioned characteristics, on which the porous filter membrane (A) having the above-mentioned characteristics was laminated. Then they were calendered at a temperature of 160℃ and joined by spot-bondings to each other. In this case, the number of dot-like engravings was changed to evaluate the area of spot-bondings, and the accompanying physical properties and effects. Table 1 shows the results of this evaluation.

Examples 5 to 6

Coating, laminating, calendering and bonding were carried out under exactly the same conditions as those in Example 3, except that the form engraved on the gravure roll was linear (Example 5 in (b)-1 of Fig.3), hexagonal (Example 6 in (c)-1 of Fig.3) and network (Example 7 in (d) of Fig.3). Evaluation was made in exactly the same manner as that in Example 3, and the results are given in Table 1.

Examples 8 and 9

Coating, laminating, calendering and bonding were carried out under exactly the same conditions as those in Example 3 except that, instead of polyethylene terephthalate taffeta woven fabric, the following materials, non-woven fabric consisting of continuous fibers (Example 8) or porous film (Example 9) were used as a water-permeable reinforcing sheet. Evaluation was made in exactly the same manner as that in Example 3, and the results are given in Table 1.

(B) Water-permeable reinforcing sheet

o Non-woven fabric consisting continuous fibers

- Material: polypropylene (SPRITOP registered trade name of Nippon Fushokufu, Ltd.)
- Water permeability: 80 cc/min./cm^2
- Tear strength (machine direction): 0.6 kg
  (traverse direction): 1.0 kg
- Weight: 50 g/m^2

o Porous film

- Material: Polyethylene (by Tamapori Ltd.)
- Water permeability: 30 cc/min./cm^2
- Tear strength (machine direction): 0.7 kg
  (traverse direction): 0.9 kg
- Pore diameter (average): 0.5 mm
- Porosity: 30%
- Thickness: 100 μm

Table 1

	Area of Spot-bondings	Water Permeability	Tear Strength		Durability
			Machine Direction	Traverse Direction	
	cm^2	$cc/min/cm^2$	kg	kg	
Comparative Example 1	0.04 *	3.0	4.2	5.3	x
Example 1	0.06	2.6	4.4	5.5	O
Example 2	0.12	2.0	4.6	5.8	O
Example 3	0.24	1.7	4.8	6.0	O
Example 4	0.34	1.2	5.0	6.2	O
Comparative Example 2	0.36 *	0.8	5.2	6.4	O
Example 5	0.24	1.8	5.0	6.3	O
Example 6	0.24	1.7	5.2	6.5	O
Example 7	0.24	1.9	5.4	6.7	O
Example 8	0.24	2.5	0.7	1.2	O
Example 9	0.24	2.5	0.8	1.0	O

Note: O : peeling did not occur x : peeling occurred

Items marked by * in Table are outside the scope of the present invention.

Durability Evaluation Procedures

The element for filtering treatment (75 cm vertical, 30 cm lateral, 1.1 cm thick) shown in Figs. 8 and 9 was prepared using a filter member in each example. After tap water was sucked at $0.2kg/cm^2$ for five minutes by this element, backwashing was performed at $0.1\ kg/cm^2$ for five minutes. After repeating this operation 10,000 times, the peeling state in a filter member was evaluated.

Example 10

The following element for filtering treatment shown in Figs. 8 and 9 were prepared using a filter member in Example 3:

- Dimensions 75 cm (vertical) x 30 cm (lateral)
- Thickness 1.1 cm

Ten of these elements were arranged in parallel inside a module for filtering treatment. Waste water used to wash clothing was poured inside the module at a flow rate of 1.8 m^3 per day. At the same time, purified water was sucked and removed from the outlet of the element at the same speed.

After seven days of treatment, elements were remove to check the external appearance. No damage occured. Backwashing was carried out by applying a pressure of 0.1 kg/cm^2 to each element, and external appearance was again checked. No damage was observed.

CLAIMS

1. A filter member comprising (1) a porous filter membrane of a synthetic resin and (2) a water-permeable reinforcing sheet laminated on said membrane (1) wherein said membrane (1) and sheet (2) are joined by spot-bondings (3) scattered over an interfacial phase of lamination wherein the area of spot-bondings at any portion thereof is in the range of 0.05 - 0.35 cm^2 per 1 cm^2 of said interfacial phase.

2. A filter member according to Claim 1 wherein said spot-bondings(3) are dot-like bondings.

3. A filter member according to Claim 1 wherein said spot-bondings (3) are linear bondings.

4. A filter member according to Claim 1 wherein said spot-bondings (3) are polygonal bondings.

5. A filter member according to Claim 1 wherein said spot-bondings (3) are bondings with a network structure.

6. A filter member according to any one of Claims 1 to 5 wherein the water permeability of said membrane (1) is 1 to 10 cc/min./cm^2.

7. A filter member according to Claim 6 wherein said membrane (1) comprises a high molecular weight polyethylene having a molecular weight of 5 x 10^5 to 7 x 10^6, and contains a large number of very fine pores providing a porosity of 60 to 90% and a pore diameter of 0.1 to 2.0 microns, the tensile strength and the tear strength in at least one of the machine and traverse directions of membrane (1) being 3.5 kg/5 cm or more, and 5 to 50 gram respectively.

8. A filter member according to any one of Claims 1 to 5 wherein the tear strength of said sheet (2) in at least one of the machine and traverse directions is 0.2 kg or more.

9. A filter member according to Claim 8 wherein said sheet (2) is a fibrous cloth.

10. A filter member according to Claim 9 wherein said cloth is a woven fabric.

11. A filter member according to Claim 9 wherein said cloth is a non-woven fabric consiting of continuous fibers.

12. A filter member according to Claim 8 wherein said sheet (2) is a porous film.

FIG. 1

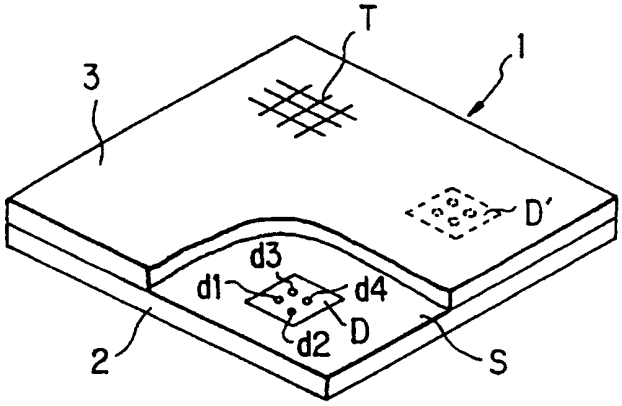


FIG. 2

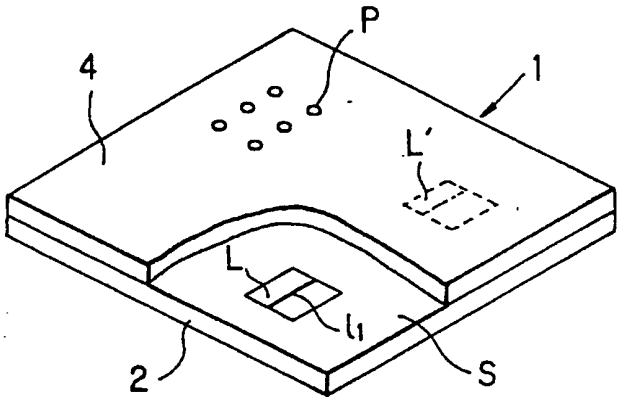


FIG. 3

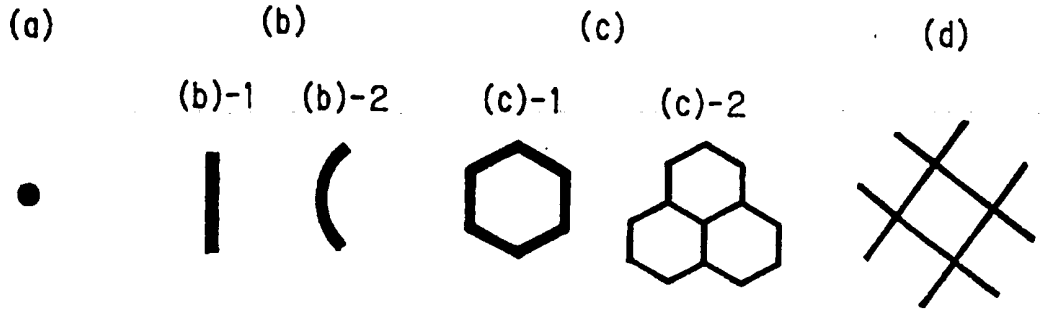


FIG. 4

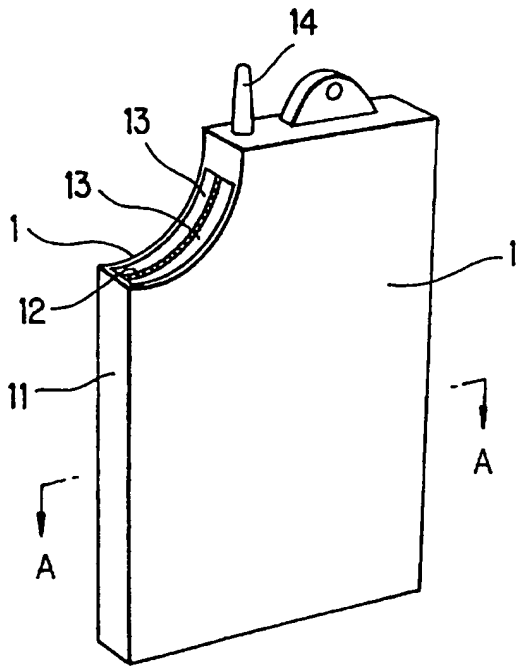


FIG. 5

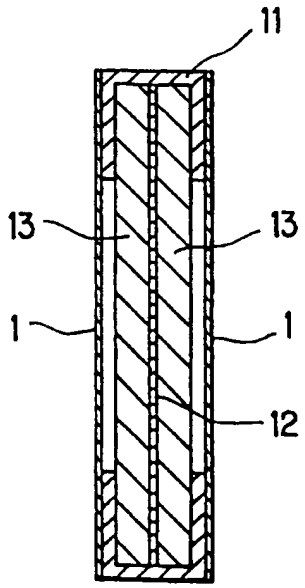


FIG. 6

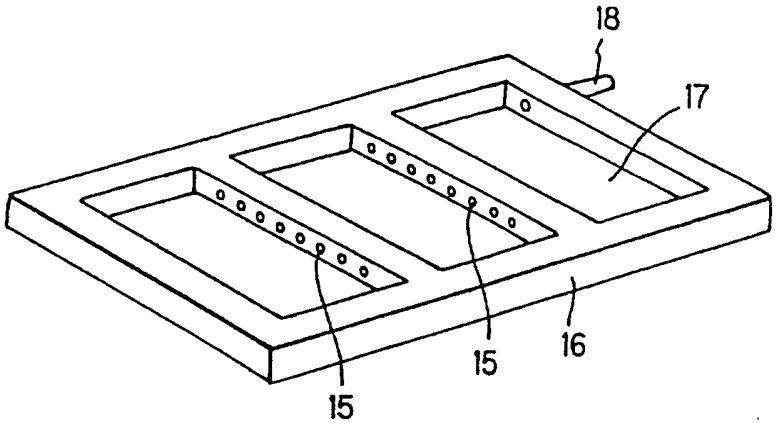


FIG. 7

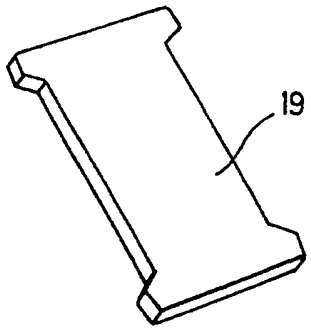


FIG. 8

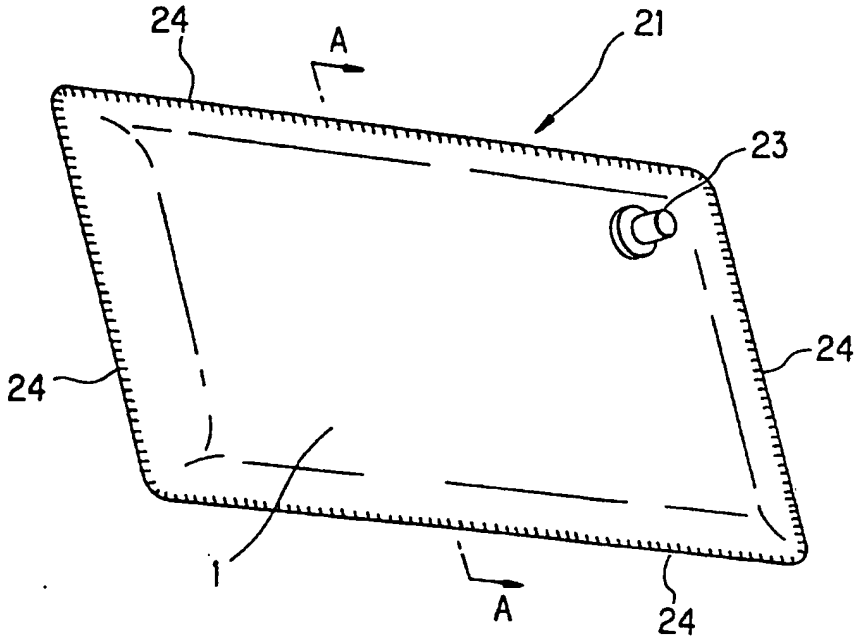
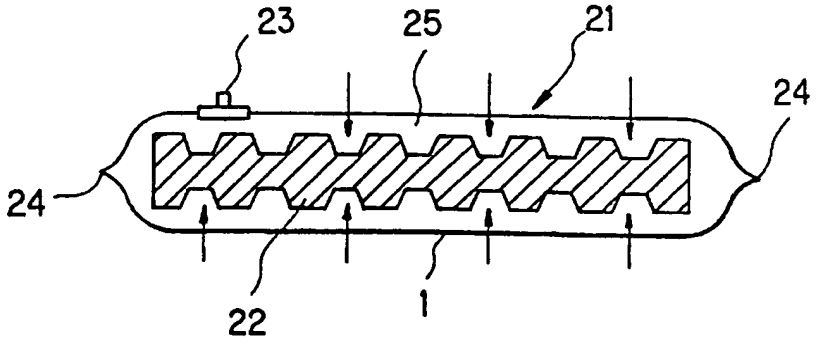


FIG. 9



INTERNATIONAL SEARCH REPORT

Internal Application No
PCT/JP 97/02340

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B01D69/10 B01D65/00 B01D63/08 B01D71/26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B01D B32B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	EP 0 457 952 A (A.E.ZACHARIADES) 27 November 1991 see column 2, line 1-9; claim 1	1,7,9,11
A	EP 0 355 214 A (TOA NENRYO KOGYO K.K.) 28 February 1990 see page 8, line 17-23; claim 10	7
A	EP 0 476 198 A (TONEN CORPORATION) 25 March 1992 see page 11, line 1-6; claim 1	7,8

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
31 October 1997	13. 11. 97

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

Internal Application No
PCT/JP 97/02340

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	EP 0 504 954 A (DSM N.V.) 23 September 1992 see claims 1,5 & JP 05 098 065 A cited in the application -----	7

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